

Pirogoff's Amputation.—Dr. ADDINELL HEWSON read the following paper on this operation, illustrating it by cases, photographs, casts, and a specimen of bone:—

CASE I. Jno. Nespar, æt. 9 years, residing with his parents at 212 Juniper St., was injured on the 28th of August, 1862, in Broad St. near Race. He was standing at the time of the accident on the projecting ledge on the side of the central one of three coal cars, which were being drawn along the railroad, when he was caught by the breaker of a car going in the opposite direction and thrown on the ground in such a manner that the last of the cars which he had been on ran over his left foot and crushed the metatarsal bones close to the tarsus. He was conveyed to the hospital immediately after the accident, and, shortly after his arrival there, the foot was amputated. The choice of operations being between an amputation of the lower third of the leg, either as a Syme or higher up, and an amputation after the method of Professor Pirogoff, we determined to try the latter. In performing it the posterior tibial artery got wounded; beyond this nothing of interest occurred, the operation having been performed by the method as originally proposed.

The flaps were brought together by leaden stitches, and all the ligatures of the arteries, save that at the plantar, were brought out at either angle. No dressing was applied over the wound, but it was left uncovered. The stump was put in a fracture-box, and the weight of a brick, about $4\frac{1}{2}$ lbs., was applied by means of a long and broad strip of adhesive plaster on the back of the leg to overcome all tendency to displacement of the os calcis, by contractions of the muscles attached to the tendo Achillis. Union of the flaps was quite perfect on the eighteenth day, when it was found that the fragment of the os calcis was firmly adherent to the end of the tibia. He was kept in bed for a month after this, and discharged from the hospital on the 17th of November, having been walking about on his stump for some time previous to this date. Fig. 1 represents a cast of the stump.

Fig. 1.



CASE II. Tom Bowers, a tall, thin, but well-formed seaman, æt. 48 years, applied for admission to the Pennsylvania Hospital, on the 3d of March, 1863, on account of distortion of his right foot, the result of an injury received on board of one of the Mississippi gunboats in the attack on Vicksburg, in the month of June previous. The foot had then been crushed by the recoil of a gun-carriage, and the bones of the metatarsus had evidently (according to the patient's account) been much comminuted, with great contusion of soft parts, but no great amount of laceration of integument. Attempts had, therefore, been made to save the foot. Extensive phlegmonous inflammation ensued, and extended up the leg, which bore the marks of the free incisions which had been made for the escape of the pus.

The foot itself was distorted by the conglomeration of the bones, through the callus thrown out for their repair and by a large mass of cicatricial tissue on the plantar surface, all of which combined to draw the toes down and prevent the patient walking on the sole. It was thus only by a very forced elevation of the fore part of the foot and throwing the whole weight on the back of the heel, that he could get along on the limb. For this deformity he applied at the hospital, desiring to have the

leg amputated. It was evident that a partial amputation of the foot was the only remedy for him. The cicatricial mass on the sole would not allow of a Lisfranc tarso-metatarsal disarticulation, or of a Chopart (inter-tarsal). It was, therefore, determined to do a Pirogoff amputation, and the patient was admitted for the purpose.

Fig. 2.



Some symptoms of delirium tremens manifested themselves on the following day, and these were soon developed into a well-defined attack of that disease. The operation was consequently delayed until the 28th of the month (March) when it was performed in the presence of the class, in connection with another amputation (a Chopart) for a recent railroad injury.

Owing to the rigidity of all the tissues of the foot, considerable difficulty was experienced in effecting sufficient dislocation at the ankle to saw off the os calcis at the proper angle. Indeed this was found impossible without injuring the soft parts. The bone had consequently to be broken after it was partly sawn through.

The stump was dressed in the same way as Nespar's, but did not do well; the healing took place very slowly. Still the patient was well enough to be discharged on the 25th of May, eleven weeks after the operation and some two months before the patient operated on—the same day—was discharged. The os calcis was noted to be firm to the tibia on the 26th day.

This man after leaving the hospital resumed his old intemperate habits, and died in the month of January of this year, about nine months after the operation.

The cast which is here presented was made after death, and, it will be seen, his stump (fig. 2) was as satisfactory in form as any of the others. The *post-mortem* examination of the case will be referred to hereafter.

Fig. 3.



CASE III. Jas. Maxwell, æt. 10 years, residing near the Drove Yard, West Philadelphia, was injured on the Penn. R. R., on the 18th of July, 1863, by a freight car, which passed over his right arm and foot, crushing the former above the elbow and the latter close up to the instep. He was immediately conveyed to the Pennsylvania Hospital, where both limbs were amputated a few hours after the accident. A flat amputation was performed in the upper third of the arm, and a Pirogoff at the ankle.

The boy reacted well, and the operation at the ankle did remarkably well under dressings of cerate and extension by means of the weight attached by adhesive strap along the back of the leg. Union took place without much suppuration, the flaps cicatrizing rapidly throughout save at the angles, and immediately in front, at a point corresponding with the union between the tibia and fibula. The os calcis was firmly adherent on the twenty-fourth day.

The operation on the arm did not, however, do so well.

Abscesses formed and burrowed up under the cellular tissue, and necrosis of the end of the humerus took place. This delayed the boy's discharge for over two months, during which time he ran about on

his stump in the wards, and thereby developed the calf of this leg to a size but little less than that of its fellow.

The cast which is here presented (fig. 3) was taken a few days before his discharge, which was given him 159 days after the operation.

CASE IV. Morris Lamney, aged 12 years, residing in Erie Street, was injured on the 10th of August, at the corner of Seventeenth and Washington Avenue, in attempting to get off a freight train of the Penna. R. R. whilst in motion. The wheels of a car passed obliquely over his right foot, crushing it close up to the ankle-joint, literally leaving nothing but the heel. He also sustained a severe blow and cut on the head, and an extensive bruise in the lumbar region. He was brought immediately to the Pennsylvania Hospital, where a Pirogoff amputation was performed within four hours after the accident occurred.

Owing to the extent of the injury on the sole and inside of the foot, the incision had to be made further back on the sole than was done in the other cases, and the portion of the os calcis preserved was consequently less.

The posterior tibial was preserved intact. Four ligatures in all were applied to bleeding orifices. The edges were united by leaden sutures, and a dry dressing was used with the extending weight. The wound united rapidly, having suppurated very little. The os calcis appeared to be firm to the tibia on the twenty-fourth day. About this time, however, he was seized with fever, rigor, and profuse sweating, which were found to proceed from suppuration in the bruised tissues on his back; a large abscess formed here, and continued to discharge after it was opened—for over thirty days. This delayed his getting up until six weeks after the operation.

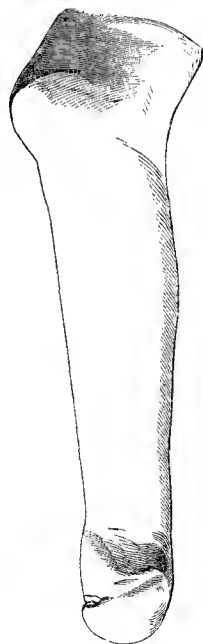
At this time the whole wound was united, save a small fistulous orifice on the front, which showed but little disposition to heal during the remainder of his stay in the institution, which continued until the 21st of November. Shortly after his discharge he visited us, and a small piece of sponge tent was then passed down into the bottom of this sinus, which was found to terminate in the bursa between the tibia and fibula. This was allowed to remain in for three days when it was removed, and the whole cavity rapidly closed up in six days' time.

He had an artificial limb applied by Mr. Palmer, in the month of January, and is making good progress in its use. Fig. 4 represents a cast of the limb. He can already run with facility on it.

CASE V. Orion Crandle, aged 20 years, from Grant Co., Wisconsin, and a private in the 7th Wis. Regiment, was wounded on the first day of the battle of Gettysburg (July 1, 1863) by a bullet in the right foot. From the battle field he was sent to the U. S. Military Hospital, Broad and Cherry, where he arrived on the 6th.

The wound did not appear at first to be a serious one, and our attention was not called to it until some time after his admission, when the foot and ankle had become very much swollen and inflamed. On probing the wound it was found that the ball had passed through the astragalus, and must have consequently implicated the ankle-joint. It was, therefore, determined

Fig. 4.



to amputate the foot, and, as the tissues of the heel appeared sound, it was decided to attempt a Pirogoff, which was done on the 28th of the month (July).

On opening the joint it was ascertained that the malleoli had both become considerably denuded by the suppuration which had been going on in the joint, so that it became necessary to remove the ends of both the tibia and fibula an inch above the joint. The denudation of the bones led us to form a rather unfavourable prognosis for the operation. The inflamed condition of the tissues, especially of those composing the anterior flap, caused delay in the process of union, which took place, however, throughout by granulations, and the portion of os calcis was found to be firmly adherent to the tibia on the 28th day after the operation. When the cicatrization of a greater part of the flaps had been accomplished it was discovered that two suppurating points, one quite on the front of the leg and the other behind the line of the fibula, communicated by sinuses with a large piece of necrosed bone evidently belonging to the fibula, and which had pushed the os calcis somewhat to the inside before it had become firm to the tibia. These sinuses were dilated by sponge tent and this portion of bone detached without even disturbing in the least the union between the tibia and os calcis.

The patient is now just beginning to throw his weight on the stump, which has been entirely healed for about a month. He ran with ease on the end of the stump before the members of the College at the meeting at which this communication was made. Fig. 5 is a representation of a cast of the limb. Two of the other cases, namely, Nespar and Lammey, were also presented at this meeting.



Fig. 5.

These five are all the cases which have been operated on by the author of this communication. In all a cure followed rapidly. In two especially the result was least to be expected. These were the adults, one of whom was a seaman, advanced in years, and who had been leading an exceedingly intemperate life; and the other a soldier, who had been wounded in a battle after long and tedious marching in pursuit of the enemy, and who was operated on four weeks after receiving his wound in a military hospital, where gangrene was prevailing to a very great extent at the time. How much the firm and speedy union of the bones in all these cases was the result of the expedient resorted to, namely the strip of adhesive plaster and weight, to prevent the contraction of the muscles attached to the tendo Achillis, is a question which we are not prepared to answer. The possibility of such a union not taking place has been the only theoretical objection apparently of any importance advanced

against the operation. But how far such an objection has been realized in the experience of others we have not been able to ascertain. Our own experience certainly points to its being of little, if any, value. For surely there could not be found two more unpromising cases for any operation than those of the adults here reported, and it is against the operation in adults especially that this objection would seem to have greatest force. The very perfect character of the union which took place between the bones in Bowers' case, as is to be seen in the specimen (see figs. 6 and 7) which

we had the good fortune to obtain after his death, furnishes as strong a refutation as a single instance could of this theoretical objection. Nothing

Fig. 6.

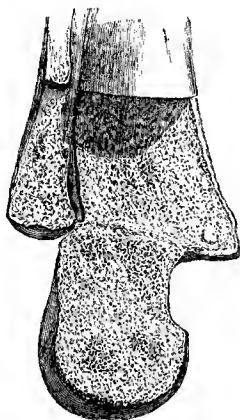


Fig. 7.



could be more satisfactory than the manner in which the cancellated structure of these bones has become blended together, making as perfect a union as ever takes place in a simple fracture or in a wound of the soft parts themselves. And this was the more remarkable considering the man's age (48 years) and his habits, which eventually produced his destruction. In cleaning the specimen much of the new cancellated structure thrown out in front, where the os calcis had to be broken, was removed.

The results of these five cases naturally suggest an inquiry as to the real value of this operation of Prof. Pirogoff.

Sufficient data have not yet been furnished to determine its rate of mortality, but admitting it to be no greater than that for amputations of the leg in the lower third, the point of election now adopted in consequence of the increased facilities of obtaining artificial legs and which has a mortality of about one in seven, or nearly one-half of what used to be the result at the old point of election in the upper third, we get by this operation of Prof. Pirogoff a stump preferable in many respects to any that can be obtained higher up the limb. In the first place this operation furnishes a stump which the patient can walk on, and this it does far better than its rival, the Syme operation, for it affords a better bony point of pressure and a greater length of limb.

All but one of the four cases operated on at the Pennsylvania Hospital were walking about freely on their stumps before they were discharged from the institution; one of them and that an adult was discharged seventy days after the operation. The exceptional case was Morris Lammey, who, it will be remembered, had a small sinus communicating with the bursa between the tibia and fibula, and which was speedily healed by the use of a single piece of sponge tent after he left the hospital.

The case at the military hospital did not walk on his stump as early as he might otherwise have done, in consequence of the necrosis of the fibula, which did not, however, prevent the union of the os calcis with the tibia, which became firm in 28 days.

No such results as these have ever been obtained from the Syme operation—for not more than one-half of the cases which have applied to Mr.

Palmer for artificial limbs have been able to bear any pressure whatever on the end of the stump, and that a long time after they were entirely healed. The only case of a Syme amputation of which we have had the opportunity of seeing the result was unable to bear his weight on it a year after it was made.

The least amount of shortening furnished by any of the cases of Pirogoff here reported was one inch, and the greatest two inches; these were both the adult cases, whereas the Syme always gives a shortening equal to the whole depth of the foot, or about from two and a half to three inches.

Then, in the second place, by this operation the tendo Achillis is in no wise injured, but, on the contrary, it is preserved intact, and becomes firmly secured to the end of the limb by the union of the portion of the os calcis to the end of the tibia. By effecting this we preserve the power of the gastrocnemius to act as a flexor of the leg, and thereby give our patients great facility of locomotion in artificial limbs.

Most persons who have undergone an ordinary amputation of the leg can walk, on an efficient artificial limb, with great ease, and even at a rapid rate, after some practice in its use; but few, if any, can however undertake to run with such an adjunct. As far as our experience goes, we have never seen a single instance, and the experience at Mr. Palmer's establishment for furnishing artificial limbs tends to confirm this; for they can recall but a single instance of any other than a Pirogoff in which this form of locomotion was possessed, and that was of a gentleman who had had his leg amputated, very low down, early in life, and who had been wearing a limb ever since. All the cases of the Pirogoff stump to which they have applied limbs have, on the contrary, soon acquired the power to accomplish this gait. The boy Nespar is the only one of those here treated who has been wearing a limb long enough to be accustomed to it, and he can run with very great facility. The soldier can run without any. Now, there is a difference between walking and running, which is not, simply, as some suppose, in the velocity with which a person moves over the ground, or the violence of the exertion which he makes to accomplish the locomotion—for a man can walk more rapidly than a child can run, and when we look at them thus moving, we at once recognize a vast difference in their gaits.

In *walking*, both feet are upon the ground at the beginning and at the end of each step, and are never both off the ground together. But in *running*, as Professor Humphry remarks,¹ the trunk, instead of being quietly delivered over from one leg to the other, which is already on the ground to receive it, is thrown forward with a spring by the muscles of the leg which is leaving the ground, and *remains for a time suspended in the air, or, rather, flying through the air.*

Now, in walking, it must be remembered, the heel of the foot which has been advanced touches the ground before the sole and toes, and that of the foot in the rear becomes elevated until its toes only are on the ground; these, then, are raised by the flexion of the ankle, and the limb, slightly shortened by the bending of the knee, is swung from behind, close beside the other limb, and advanced in front of it so as to be planted on the ground as its fellow had been.

But in *running*, the heels scarcely, if ever, touch the ground, and "the feet revolve almost exclusively upon the balls of the toes, and the advanced limb touches the ground in a more bent position, both as regards its knee and hip-joints." Indeed, both the carrying and the swinging limb are

¹ Humphry's Human Skeleton, London, p. 587.

more bent in running than in walking, when they are placed vertically beneath the trunk, whereby the swinging movement, and, consequently, the step, are still further quickened, the propulsive power is increased, and the body is carried at a lower level.

It is thus evident there is a difference between walking and running, both as regards the movements of the feet and the flexion of the limbs. It is, therefore, important for us to determine which of these is really essential.

Now it is well known that a person can walk on his heels. So, also, it is possible, although very fatiguing, for him to propel himself, in the same way, after the manner characteristic of running—that is, with a period during which neither extremity is touching the ground. Again, one can run, awkwardly it is true, with his feet held rigidly at such an angle as will cause them to come flat on the ground at each step.

It is, therefore, evident that the movements of the feet, which are different in the two gaits, and important in both, are not absolutely essential in either.

Then, again, a person with an ankylosed knee-joint can manage to walk with such, by swinging the limb around from the vertical line, whilst his weight is being borne by the other. He cannot, however, run with such a knee-joint, and this shows that flexion of the knee is essential to that gait. But flexion of the knee, it will be said, is performed chiefly by the hamstring muscles, and the gastrocnemius is always spoken of as an extensor of the foot.

This we will admit to be the case in walking, where there is not much flexion of the knee required, but great latitude of movement in the foot; but in running, especially at a rapid rate, the foot, it will be remembered, is kept in a more or less extended position, and extreme and rapid flexion is required at the knee-joint. Under such circumstances the action of the gastrocnemius must be either to steady the foot in its extended position or flex the knee. Its connection by the tendo Achillis to the os calcis naturally suggests the idea that the chief function of this muscle is that of an extensor of the foot, the heel of which can only be drawn up by this tendon; but we overlook the fact that there is another muscle, and a powerful one, attached, by this same tendon, to the heel, whose function is more evidently that of an extensor of the foot. We refer to the Soleus, which Professor Pancoast has demonstrated, by a very extensive clinical experience, to be the source of the retraction or elevation of the heel in various forms of club-foot. He has pointed out the fact that the gastrocnemius is flaccid in these cases, and the soleus hard, and in the state of firm tension—so that it is not so very evident that the gastrocnemius is chiefly occupied in extension of the foot.

In what other way can an amputation of the leg low down diminish or destroy the power of running—seeing it is preserved by the Pirogoff—unless it be by destroying the part which the gastrocnemius performs in the flexing of the knee? for the difference in the length of the stump is not sufficient to account for it, and this muscle is the only one in any way concerned in such motion, which function is entirely destroyed in the one, and not in the other.

In every amputation of the leg it will be found that atrophy always ensues of the muscles which are involved in the operation.

This at first resembles that which occurs in a broken limb, from long rest and disuse—but, unlike it, it does not cease when the patient begins to walk about, even on an artificial limb; on the contrary, it increases, even in young and growing persons, so that they have, from time to time, to

increase the thickness of covering or stocking with which they cover the stump, to keep it fitting properly in the socket originally made to receive it.

The rapidity of the rate at which this wasting goes on in a stump does not seem to be much influenced by the point at which the operation has been performed, as will be seen by the following table, prepared by one of my pupils, Mr. Abraham Sharples, from measurements taken in the order in which the cases presented themselves, in Mr. Palmer's establishment for artificial limbs. No data are given by which an approximation can be reached of the length of time which had elapsed in these cases after the operation; but, in the large number of cases furnished for each class, it will be but fair to suppose that there was no difference in this respect.

Location of the amputation.	No. of cases.	Mean measurement of sound leg at the largest part.	Mean measurement of stump.	Difference.
In upper third . . .	56	13.58	11.20	238
" middle " . . .	42	13.72	11.21	261
" lower " . . .	15	14.03	11.73	230
	<hr/> 113	<hr/> 13.77	<hr/> 11.38	<hr/>

This same atrophy goes on in all the muscles of the leg after a Pirigoff, save the gastrocnemius, which, soft and flabby at first, soon becomes firm, and can be felt in a state of more or less tonic tension when the patient stands on his stump.

Thus, Crandle, who is just beginning to walk, has the muscle so soft and flabby that it was pushed to the side in an attempt to take a cast of the limb; whereas the limb of the man Bowers, who, it will be remembered, died within a year after the operation, and about seven or eight months after he had begun to walk freely on the stump without any artificial adjunct, presented, at the *post-mortem* examination, the most satisfactory evidence of the preservation of this muscle, its healthy, fleshy fibre contrasting singularly enough with the flabby and greasy condition of the other muscles of the leg.

Then the boy Nespar, who has been walking on one of Palmer's legs for a year, has never had to use any additional covering than that originally put on his stump.

All these reasons seem to us to furnish the strongest arguments for the preference we give to this operation of Professor Pirogoff over any amputation of the leg. But this is not all; we even think it preferable to either a Chopart (an intertarsal) or a Lisfranc (a tarso-metatarsal) disarticulation in the foot, where they can be performed, and for the following reasons:—

In both the Lisfranc and Chopart, and especially in the latter, there is a tendency to retraction or elevation of the heel, so that the weight of the body is thrown, in walking, on the cicatrix or end of the stump, from either of which serious inconvenience must ensue.

As an evidence of the seriousness of this inconvenience, we may mention that, as long ago as 1815, M. Villermé stated that one-twentieth of the soldiers who had undergone amputation in the tarsus, and were admitted in the *Hôtel des Invalides*, had to be subjected afterwards to amputation of the leg on account of inflammation and ulceration of the stump.

Now this difficulty is universally attributed to the contraction of the muscles of the tendo Achillis, and the various expedients recommended for its prevention and relief have been based on this notion, but a careful consideration of the form of the human foot and its manner of supporting the

body will show this distortion must necessarily follow these operations of Lisfranc and Chopart, independent of any muscular action which may be brought into play.

Thus the foot is constructed in the form of an arch, the summit of which is at the astragalus. The two pillars of this arch differ very much from one another. The posterior one is about half the length of the anterior. It consequently descends far more abruptly. It also consists of but a single bone, the os calcis, whereas the anterior pillar not only includes the metatarsal, but also the cuboid, the three cuneiform, scaphoid, and the head and neck of the astragalus, "so that when the foot rests flat upon the ground the chief part of the weight is transmitted from the tibia forwards."¹

Now lop off a portion of this anterior pillar, and that which is left must of necessity become so much depressed that it will touch the ground in standing, for it is through it that "the chief part of the weight is transmitted." This will throw the weight still more forward, and less of it will be transmitted through the os calcis. Indeed, the more perfectly a foot is arched, that is, the more vertical its os calcis is placed, the worse must be the distortion after one of these operations; for the plantar face of the os calcis and the lower edge of the scaphoid facet of the astragalus must, in the Chopart operation, be driven on the ground when any weight is thrown on the limb, and a similar depression, though in a less degree, must occur in the Lisfranc.

A complete and permanent severing of the tendo Achillis cannot have any effect in preventing such a consequence, no matter what influence the muscles attached to that tendon might exert in increasing the evil.

To all this it may be answered that cases of successful prevention of the elevation of the heel after these operations by a division of the tendo Achillis have been reported, by such men as Velpeau, Robert, and others. This we cannot deny; but others equally reliable have reported tenotomy an absolute failure in these cases; and how are we to reconcile the discrepancy between such authorities?

We had thought ourselves successful in preventing the difficulty after the Lisfranc operation by means of the weight, as we have used it after the Pirogoff; for when we discharged the cases (four in number) from our care, they did not evince much if any disposition to it, but when we came to examine these cases a year or more afterwards we discovered the deformity as complete as when no expedient is resorted to. A temporary success was, with us, as it has been, probably, with others, mistaken for a permanent result. Indeed, it would seem impossible for any expedient looking to a prevention of the contraction of the muscles of the calf as the source of the difficulties to succeed; and it is equally impossible to restore the proper elevation of the os calcis in front after either of these operations. Hence we think our preference for the Pirogoff well founded.

Spotted Fever. Dr. JEWELL reported a case.

The following case of the epidemic disease which has prevailed in some sections of our city for upwards of a year, visiting several of the adjoining neighbourhoods, and making its appearance in other districts of our country under the popular, but perhaps erroneous title of "spotted fever," may prove of some interest to the pathologist, especially through the revelations

¹ Humphry, *op. cit.*, p. 494.